Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Load (TMDL)

for

Dougher Branch
Lawrence County, Missouri

DRAFT

DRAFT Total Maximum Daily Load (TMDL)
For Douger Branch (Chat Creek)
Pollutant: Zinc

Name: Douger Branch (Chat Creek[1])

Location: Lawrence County near Aurora, Missouri

Hydrologic Unit Code (HUC): 11070207-010001

Water Body Identification (WBID): 3168

Missouri Stream Class: C[2]

Beneficial uses:
- Livestock and Wildlife Watering
- Protection of Aquatic Life
- Protection of Human Health associated with Fish Consumption
- Warm Water Fishery
- Whole Body Contact Recreation – Category B

Size of Impaired Segment: 2.0 miles

Legal Description of Impaired Segment: From the center of Section 11, T26N, R26W (downstream) to W ½, Section 7, T26N, R25W (upstream).

Pollutant: Zinc

Pollutant Source: Aurora Mines Area

TMDL Priority Ranking: Low

1. Background and Water Quality Problems

Area History[3]:
On April 7, 1845, Joseph Schooling, Joseph Rinker and Robert Taylor met at Taylor's farm (two and one-half miles northeast of what is now Mount Vernon) to organize the new Lawrence County. It was created out of parts of Dade and Barry counties and named for James Lawrence, a naval hero of the War of 1812.

[1] This creek is called Chat Creek on US Geological Survey topographic maps, but listed as Douger Branch in Missouri's Water Quality Standards. It will be referred to as Douger Creek throughout this document.
[2] Class C streams may cease to flow in dry periods but maintain permanent pools which support aquatic life. See the Missouri Water Quality Standards (WQS) at 10 Code of State Regulations (CSR) 20-7.031(1)(F)
[3] Down Turnback Trails, A Sketch Book of Lawrence County, Missouri, 1845-1995. Kathy Seneker Fairchild, Ed. Pub. Lawrence County Historical Society and Lawrence County Record Inc. Copyright 1992.

The county's formation was celebrated on the Fourth of July, 1845, when almost the entire population of the county met at centrally located Mount Vernon (containing only one house at the time) for a barbecue and a "bran dance." A bran dance is prepared as follows:

> "A plat of ground was cleared off and leveled down hard, and smooth, afterwhich a layer of one or two inches of wheat bran was scattered on the surface, and the "Ball Room" was declared completed, and ready for the dance; and perhaps at no other time or place…was a dance more universally enjoyed, and appreciated." A single violinist, who alternated between the only two tunes he knew, provided the music!

The speed of settlement and progress in house building in Lawrence County was swift. The county came into existence in 1845 and by the next spring it had a frame courthouse and a log jail as "appropriate accommodations for the more lawless element of society." By 1855 it had a brick courthouse and, in 1900, the present one was built of locally quarried limestone. The brick building cost $7,000. The limestone one (erected 45 years later) cost $50,000 and nobody had to go bankrupt, to the county's great surprise.

No major battles were fought in the county during the Civil War, but there were numerous skirmishes, some severe, and many soldiers were killed. By the war's end, the county population was less that 4,000. Hundreds of farms and houses were destroyed, but people returned and before long the ravages of war were obliterated.

Land Use and Soils:

Douger Branch, also known as Chat Creek, is about five miles long with a watershed of 5,251 acres (or 8.21 square miles). The creek begins in the southeast corner of Lawrence County and flows west to join the uppermost section of the Spring River. On its way, it runs through abandoned mine lands and the City of Aurora.

Lawrence County lies on the tablelands of the Ozark Range at a mean elevation of 1,300 feet. It contains 606 square miles. In 1901 this description was given[4]: "In the northwest, the county is broken and hilly; elsewhere it is about equally divided between prairie uplands and timber fringed bottoms. The bottomlands are extremely rich, never failing to produce crops. All the streams have solid beds with good fords. Bridges are unknown. Limestone and dark yellow sandstone are found near Mount Vernon and Marionville. Lead and zinc abound." Present day land use in the Douger Branch watershed is 77 percent grassland, 9 percent forest and woodland, 9 percent urban and 5 percent barren (abandoned mine lands). There is no significant acreage in row or close-growing crops (See Appendix A).

Soils on the uplands around Douger Branch are Newtonia silt loam and Wilderness cherty slit loam. Their slopes are 1-3 percent and 2-9 percent respectively. They are well drained to moderately well drained with moderate permeability. Runoff is slow to medium. Wilderness has a fragipan layer at 11 inches. On the slopes the soils are Clarksville-Nixa cherty silt loams with 5-14 percent slopes. They are moderately well drained. The bottomlands have Secesh-Cedargap silt loams, with moderately rapid permeability and medium runoff. Scattered through the area is also Dumps-Orthents complex "soil" with gentle to steep slopes. Dumps is mine spoil, mostly limestone and chert from lead and zinc mining. Orthents is filled and covered shallow open trenches.

[4] Encyclopedia of the History of Missouri. Vol. IV. 1901. Howard Conard, Ed. New York, Louisville and St. Louis. Halderman, Conard and Company, Proprietors

Defining the Problem:
The Aurora mining district (hereafter referred to as the Lawrence County Mining Sites) opened in 1873. Lead and zinc were abundant and the district was soon second only to Joplin in output. Douger Branch, as already stated, runs through the City of Aurora. In the past, underground mining of lead and zinc occurred in the Baldwin Park area just northeast of Aurora in the upper Douger Branch watershed. Douger Branch has elevated levels of zinc in that area. After mining ceased in 1955, these underground mines filled with groundwater. Zinc minerals in the walls of the mines dissolved into this groundwater. Zinc-contaminated groundwater from these mines is now resurfacing into a small tributary of Douger Branch (locally called Baldwin Park Tributary) along the railroad tracks about 0.5 miles east of town. Zinc levels in this tributary are especially high (see data in Appendix C). Because compounds of zinc are generally soluble in neutral and acidic solutions, zinc is readily transported in most natural waters and is one of the most mobile of the heavy metals. Hardness, dissolved oxygen, temperature and synergistic (more than the sum of the individual components) with other compounds all affect the toxicity of zinc to aquatic life[5]. Zinc is an essential nutrient to aquatic and terrestrial organisms, but in excess can be highly toxic and has the tendency to bioaccumulate (build up in organisms) in the environment. A number of behavioral and physiological effects have been reported when test organisms have been exposed to increased zinc levels. Behavioral responses in fish include avoidance and changes in feeding rate and movement patterns. Physiological changes in fish include increased ventilation rates, frequency of coughing and a decrease in oxygen utilization.[6]

The Lawrence County Mining Sites (LCMS) are approximately 2,400 acres in size and encompass two large mining areas, labeled the East Mining Area (EMA) and West Mining Area (WMA), in and around Aurora. Douger Branch flows through both the southwestern portion of the EMA and the center of the WMA. The hydrology (the way the water flows) of the area is very complicated. Deep gravel-filled and sand-filled channels cut across the watershed, creating paths for groundwater to move relatively easily compared to moving through the surrounding carbonate rock. Extensive underground mining created a similar situation below ground. Because of this, some sections of the creek disappear entirely underground and "reappear" further downstream. Baldwin Park (see map in Appendix B) is in the EMA.

The U.S. Environmental Protection Agency (EPA), Region VII, first investigated Baldwin Park in October 1979. The investigation was initiated because a portion of Baldwin Park was used as a municipal dump following the closure of the mines. When it became a Superfund site, it was commonly called the Baldwin Park Dump. In 1987, EPA conducted a removal action for the area affected by the municipal dump which included excavating and capping dioxin contamination at the site, however, mining waste remained. Results from the subsequent quarterly monitoring of groundwater by EPA showed elevated levels of lead, cadmium and zinc in the groundwater beneath the site. In addition, acute water toxicity data collected by the Department of Natural Resources' Water Protection Program (WPP) showed impairment of the water quality in Douger Branch. At the WPP's request, the department's Division of Geology and Land Survey (DGLS) conducted a study (completed in September 2001) which showed that dissolved heavy metals were originating

[5] Upper Sacramento River TMDL for Metals, California Environmental Protection Agency, 9/25/01. www.swrcb.ca.gov/rwqcb5/TMDL/upperSacCdCuZn.html
[6] Red Clay Creek TMDL, Delaware Natural Resources and Environmental Control, 8/1/99. www.dnrec.state.de.us/DNREC2000/Library/Water/rcctmdl.pdf

from flooded underground mine workings just east of Aurora. Further, the department's Hazardous Waste Program (HWP) completed a site screening investigation on March 28, 2001. The HWP then recommended that the LCMS be entered into the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS also called Superfund) and that a combined Preliminary Assessment/Site Inspection (PA/SI) be conducted. This report was completed in May 2002. Sampling of the area's groundwater, surface water, sediments, surface soils and subsurface soils concluded that mine waste contamination was present at Baldwin Park, Mill Area #1 and Mill Area #2. The site was referred to EPA for Removal Action. In November 2002, EPA completed Removal Action of contaminated soil from residential yards, most of which were located inside the city limits of Aurora.

As already noted, Baldwin Park has a history of lead and zinc mining on the property. This is particularly noticeable in the southeast corner of the park. The HWP is in the process of using federal Brownfield[7] funds for a redevelopment project on the southeast corner of the park. By reducing metals mobility and availability on site, a reduction in the amount of zinc coming from the site may also be achieved.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

Designated Uses:
The designated uses of Douger Branch, WBID 3168, are:

- Livestock and Wildlife Watering
- Protection of Aquatic Life
- Protection of Human Health associated with Fish Consumption
- Warm Water Fishery
- Whole Body Contact Recreation – Category B

Use that is impaired:
Protection of Warm Water Aquatic Life

The stream classifications and designated uses may be found in the water quality standards (WQS) at 10 CSR 20-7.031(1)(C) and Table H.

Anti-degradation Policy:
Missouri's WQS include EPA's "three-tiered" approach to anti-degradation and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

[7] With certain legal exclusions and additions, the term `brownfield site' [Brownfield] means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant. This Brownfields Site definition is found in Public Law 107-118 (H.R. 2869) - "Small Business Liability Relief and Brownfields Revitalization Act" signed into law January 11, 2002.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria:
The criteria for zinc may be found in Missouri's WQS 10 CSR 20-7.031 Table A and varies depending on the hardness of the waterbody. Current (December 2005) WQS revision includes new metal criteria for zinc, lead and other metals. Now the criteria determination is based on EPA's guidance (EPA820B96001). For the protection of aquatic life and human health associated with fish consumption, metals (other than mercury) shall be expressed in dissolved form (10 CSR 20-7.031 (4)(B) 2). The criteria are expressed in microgram per liter (μg/L[8]) of dissolved metal. The formulas for zinc criteria are shown below:

Acute: $e^{(0.8473*\ln(\text{Hardness}) + 0.884211)} * 0.978 = \mu g/L$ of Dissolved Zinc
Chronic: $e^{(0.8473*\ln(\text{Hardness}) + 0.785271)} * 0.986 = \mu g/L$ of Dissolved Zinc

Where "e" is the base of the natural logarithm (also called exponential), "ln" is the natural logarithm, and the conversion factors (0.986 and 0.978) are translators from total recoverable to dissolved zinc. From this mathematical relation, it is apparent that the dissolved zinc concentration is positively related to hardness. As water hardness increases, so does the criterion. It follows that hardness mitigates the toxicity level of dissolved zinc on aquatic life (EPA-440/5-87-003). The data show that there is no significant relation between zinc concentration (dissolved or total) and stream flow.

Numeric Water Quality Target:
There are only two hardness records in Douger Branch watershed. To obtain a better representative hardness value, all records in Spring River watershed were used. There are 543 hardness records that have an average of 180, a standard deviation of 87, and a 25^{th} percentile of 141 mg/L[9]. Dissolved zinc criteria corresponding to 141 mg/L hardness is 143 μg /L. Expressed as total recoverable zinc, the target is 145 μg /L.

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[8] 1 microgram (μg) = 10^{-6} gram and is equivalent to 1-part-per-billion (1 ppb).
[9] From Missouri's Water Quality Standards 10 CSR 20-7.031 (1) (Y): Water hardness—The total concentration of calcium and magnesium ions expressed as calcium carbonate ($CaCO_3$). For purposes of this rule, hardness will be determined by the lower twenty-fifth percentile value of a representative number of samples from the water body in question or from a similar water body at the appropriate stream flow conditions.

3. Loading Capacity

The Loading Capacity (LC) is the greatest amount of pollutant loading that a stream can assimilate without becoming impaired. It is equal to the sum of the Load Allocation (LA), the Wasteload Allocation (WLA) and the Margin of Safety (MOS). The load is calculated as pounds per day using the following general formula:

(flow in ft^3/sec*)(dissolved zinc in mg/L)(5.395*)= pounds/day*

*5.395 is the constant used to convert ft^3/sec times mg/L to pounds per day.

There are 43 dissolved and 10 total zinc records collected in this watershed. Because of this data limitation, the TMDL calculation is performed for dissolved zinc only. In addition, the outlet of Douger Branch watershed is more than 60 miles upstream of Missouri/Kansas state line. Therefore any reduction in dissolved zinc to achieve Missouri WQS will undoubtedly achieve Kansas standard (which is stated as total recoverable zinc).

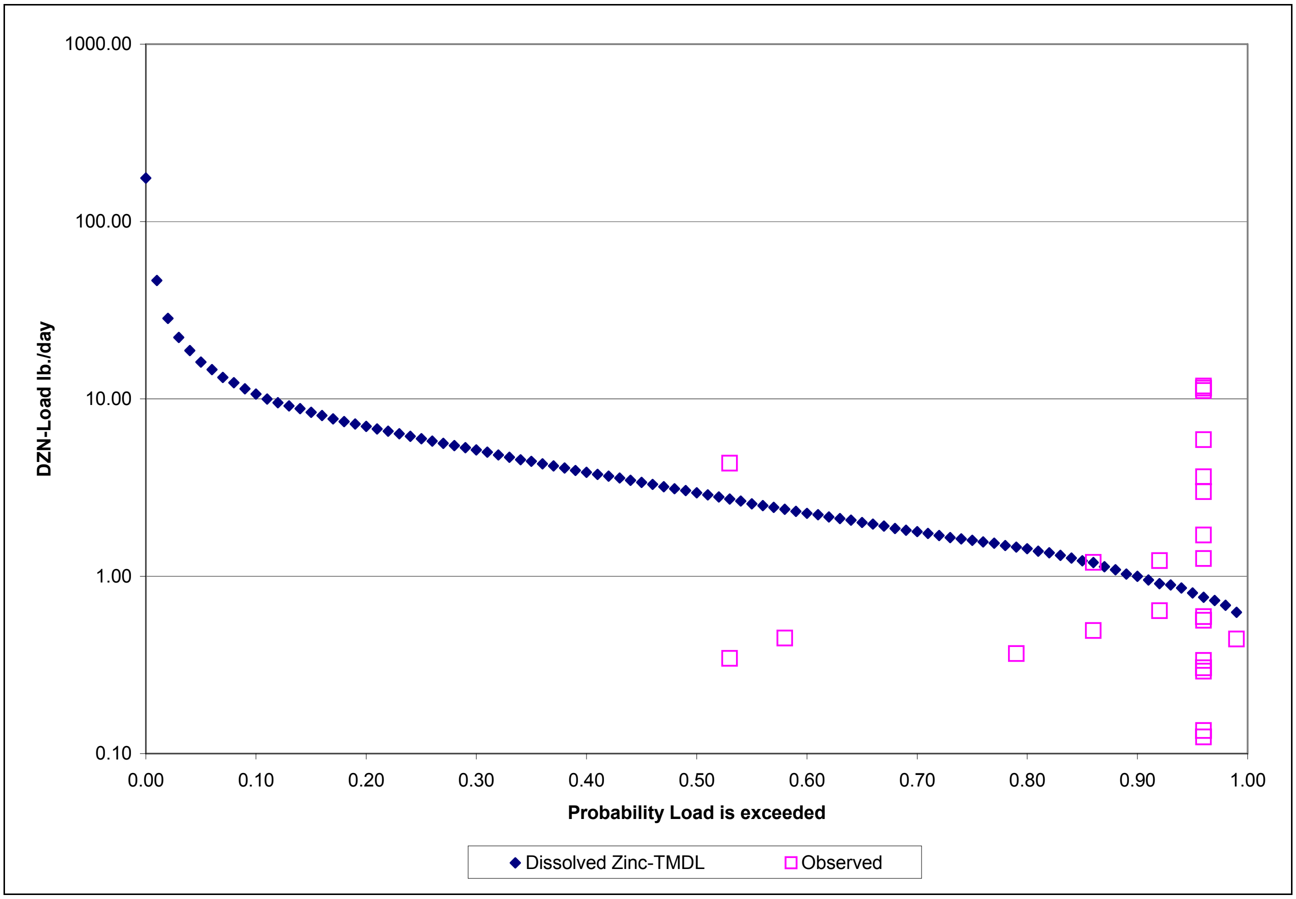
Modeling Approach:

The modeling approach consisted of creating a load duration curve at the outlet of the impaired segment's watershed and determining the TMDL at every flow probability. A TMDL is the product of the standard of concern (in mg/L), the expected flow at the corresponding probability (as ft^3/s), and a conversion factor (5.395). The resulting load is expressed in pounds per day. The existing load of zinc (calculated from actual stream samples) is plotted against the TMDL curve based on the probability of its corresponding flow (Figure 1). Where flow was not reported with water quality data, estimated average daily flow at the site on the same date was used to calculate zinc load. A similar procedure was employed to estimate hardness for observed[10] zinc data. Because zinc standard is hardness dependent, and the zinc load increases with flow, the TMDL is expressed in probability flow at specific hardness.

Daily average flow data at the outlet of Douger Branch watershed were synthesized from data collected at USGS 07185765 on Spring River, based on the ratio of their respective watershed sizes.

[10] Observed zinc or observed load refers to the amount of zinc actually found in the stream, as shown from sample collection. The TMDL, on the other hand, is a calculated amount of zinc that is the most a stream can assimilate (or absorb) and still meet water quality standards.

Figure 1: Load Duration Curve (Dissolved Zinc TMDL) and Observed Loads



The TMDL curve sets the maximum load at different flow probabilities. In a stream that is not impaired, all observed data points should fall on or below this curve. In general, any excursions (points above the line) at probabilities greater than that of baseflow (0.65 for Douger Branch) are caused by point sources (and ground seepage in the case of abandoned mine lands).

4. Load Allocations (Nonpoint Source Load)

The LA is the maximum allowable amount of the pollutant that can be assigned to nonpoint sources.

When the dissolved zinc TMDL is plotted against the existing loads (Figure 1), it shows that all observed loads corresponded to probability flows greater than or equal to 0.53. This means that all data were collected at low flow conditions. Since there are no data from high flow events, which contribute runoff from nonpoint sources, a LA reduction cannot be recommended. However, the TMDL curve (Figure 1) sets the LA at every flow probability and the total loading from point and nonpoint sources shall not be greater than the stream's assimilative capacity at the indicated flow.

With continued monitoring, any data collected under high flow conditions should be able to define the problem more accurately and give a baseline with which to compare data collected after watershed improvements have been made.

5. Wasteload Allocation (Point Source Load)

The WLA is the maximum allowable amount of the pollutant that can be assigned to point sources.

At baseflow condition (0.65 probability corresponding to 2.6 ft^3/s), there is no runoff and the LA is therefore zero. Using the baseflow and the numeric water quality target results in the following LC for the creek:

$$LC = WLA + Seepage = 2.6\ ft^3/s * 0.143\ mg/L * 5.395 = 2.0\ lb./day$$

There is one point source in the watershed, Aurora Wastewater Treatment Facility (WWTF), Permit #MO-0036757. This facility is regulated by the state permitting system. This is Missouri's program for administering the National Pollutant Discharge Elimination System (NPDES) program. All facilities must obtain a Missouri State Operating Permit and then meet the limits outlined in the permit. Aurora WWTF has a design flow of 2.0 million gallons per day (that is 3.1 cubic feet per second ($ft^3/$)) with a total recoverable (TR) zinc limit of 0.172 mg/L as a daily maximum at its main outfall. The permit includes monitoring only for TR zinc at outfall #002 and instream monitoring up and downstream of both outfalls.

Table 1: City of Aurora Zinc Load at Current Effluent Limits

		Design Flow	Permit Limit (Daily Max)		Load (lb./day)	
Permit #	Name	ft^3/s	D ZN Mg/L	TR ZN mg/L	D ZN	TR ZN
MO 0036757	Aurora WWTF	3.1	0.170	0.172	2.84	2.88

Permit limit of dissolved zinc was derived from the limit of total recoverable using this formula:
D ZN = 0.986*TR ZN

Using the load formula, the WLA corresponding to full capacity of Aurora WWTF is:

$$WLA = 3.1\ ft^3/s * 0.143\ mg/L * 5.395 = 2.4\ lb./day.$$

At design flow and current permit limits, Aurora WWTF would generate 2.84 lb./day [3.1 * 0.170 * 5.395] (Table 1). The required effluent load reduction is then estimated at 15 percent [(present load – WLA)/present load or (2.84 – 2.4)/2.84].

The 95th percentile of <u>observed</u> loads measured at or below baseflow (baseflow being 2.6 ft^3/s) is 11.8 pounds per day. The difference in this observed load and the WWTP load (11.8 – 2.84 = 8.96 lb./day) is probably generated by seepage from old zinc mineshafts. In a September 2001 report on this creek, Jerry Prewett[11], suggested that mine discharge from old workings in parts of the watershed may account for some of the flow in Douger Branch.

[11] Mr. Prewett is employed by the department's Division of Geology and Land Survey

It has already been noted that the design flow of the WWTP is more than what Douger Branch contains at baseflow (3.1 as compared to 2.6 ft^3/s). Theoretically, when the facility is running at full capacity (at design flow) during stream baseflow discharge, total stream flow below the outfall would be about 5.7 ft^3/s. The corresponding TMDL would be 4.4 [= 5.7 * 0.143 * 5.395] pounds of dissolved zinc per day. Subtracting the WLA of 2.4 lb./day gives 2.0 lb./day as the target load for mine seepage. With this calculation, input from seepage should be reduced by 78 percent [(8.96 - 2.0)/ 8.96]. From a regulatory standpoint, seepage which is a ground water discharge, shall not be considered a point source. It may be viewed as a nonpoint source that is not driven by runoffs.

At stream flows greater than 5.7 ft^3/s, the total loading from point and non-point sources shall not be greater than stream assimilative capacity at the indicated flow. For example, if stream flow is 7 ft^3/s, then its assimilative capacity is 7 * 0.143 * 5.395 = 5.4 lb./day. In this example, nonpoint source contribution should be less than 3 lb./day (5.4 – 2.4) [LA = TMDL – WLA].

6. Margin of Safety

The MOS is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit - Reserve a numeric portion of the loading capacity as a separate term in the TMDL.
(2) Implicit - Incorporate the MOS as part of the critical conditions for the WLA and the LA calculations by making conservative assumptions in the analysis.

The MOS for this calculation is implicit. It is expressed in conservative approaches that were used to determine TMDL target:

- Hardness: using the 25th percentile of hardness data, instead of any measure of central tendency, accounts toward the MOS that is built in the criteria.
- Using all hardness data collected in Spring River watershed, that includes Douger Branch watershed, adds robustness to the data.

7. Seasonal variation

There is no data during high flow conditions to allow testing for any relationship between seasons, flow, and dissolved zinc concentration. It is, however, apparent that there is a constant seepage at very low flows.

8. Monitoring Plan for TMDLs Developed Under the Phased Approach

The department conducts annual ambient water quality monitoring on Douger Branch. This monitoring is ongoing. In addition, a sediment study is scheduled for 2006. Also, monitoring of metals levels is built into the Brownfields project. If post-implementation monitoring reveals that WQS are still not being met, this TMDL will be re-opened and re-evaluated.

9. Implementation Plans

Point Sources:
The permit for Aurora's WWTP was renewed in January, 2006 with limits for TR zinc of 172 µg /L. Although there have been occasional excursions of these limits as reported by the WWTP in their self-monitoring data, there have been no violations of WQS recorded in Douger Branch below the WWTP (see data in Appendix C). Therefore, adjustment of these limits will not be considered until this permit comes up for renewal or modification. Reduction in the loads from mine seepage is considered under nonpoint sources next.

Nonpoint Sources:
The southeastern corner of Baldwin Park drains into the Douger Branch watershed and is therefore considered to heavily influence the water quality in Douger Branch. As stated earlier, the department is using federal Brownfield funds for a redevelopment project in Baldwin Park.
In 2005, work proceeded on creating an attractive park for runners, walkers, anglers and anyone just wanting a place to get out in nature. Some of the work planned is to cut and disc the most heavily contaminated areas, then apply a phosphorus treatment (triple super phosphate) to reduce the bioavailability of heavy metals. Bioavailability is a measure of the ease by which contaminants are absorbed by organisms. By reducing metals mobility and bioavailability on site, it is hoped that a reduction in the amount of zinc coming from the site may also be achieved. Grading, application of biosolids and revegetation will follow the phosphorus treatment. These treatments should serve to stabilize windblown and dissolved heavy metals. Following revegetation, trails through the area will be built and subsidence pools made available for fishing. While it is true that there are underground mines that discharge to the creek, because the hydrology is complex it is unknown if reducing zinc in surface runoff will reduce zinc levels in the creek or not. There are many subsidence pits that are now ponds. If runoff is reduced to these pits, there is the potential for water quality improvement to the creek. Only completion of the project and subsequent monitoring will answer those questions.

Another element to consider is the reduction of zinc levels over time. There is a finite amount of zinc ore subjected to erosion from groundwater action. As time passes, these sources will be depleted and zinc levels should eventually return to normal, provided no new mining operations expose more material. Also, preliminary results from a small wetland remediation project by the department's Land Reclamation Program and HWP near the town of Oronogo (near Joplin) shows a removal rate of approximately 65 percent for dissolved zinc and 70 percent for TR zinc. These factors have the potential to result in reduced zinc in the mine seepage and hence improved water quality in the creek.

This TMDL will be incorporated into Missouri's Water Quality Management Plan.

10. Reasonable Assurance

The department has the authority to write and enforce state operating permits. Inclusion of effluent limits into a state permit, and quarterly monitoring of the effluent reported to the department, should provide reasonable assurance that instream water quality standards will be met.

In most cases, "Reasonable Assurance" in reference to TMDLs relates only to point sources. As a result, any assurances that nonpoint source (NPS) contributors of zinc will implement measures to reduce their contribution in the future, will not be found in this section. Instead, discussion of reduction efforts relating to NPS can be found in the "Implementation" section of this TMDL.

11. Public Participation

This water quality limited segment of Douger Branch is included on the approved 2002 303(d) list for Missouri. After the department develops a TMDL, it is sent to EPA for examination and then the edited draft is placed on public notice. The public notice period for the draft Douger Branch TMDL is April 28 to May 28, 2006. Groups receiving the public notice announcement include the Missouri Clean Water Commission, the Water Quality Coordinating Committee, Aurora WWTF, Lawrence County head commissioner, Lawrence County Soil and Water Conservation District, the Aurora Parks and Recreation department, Stream Team volunteers in the county (43), and the appropriate legislators (2). Also, the notice, the Douger Branch Information Sheet and this document are posted on the department Web site, making them available to anyone with access to the web. All comments received and the department's response will be placed in the Douger Branch docket [file] along with any other documentation.

12. Administrative Record and Supporting Documentation

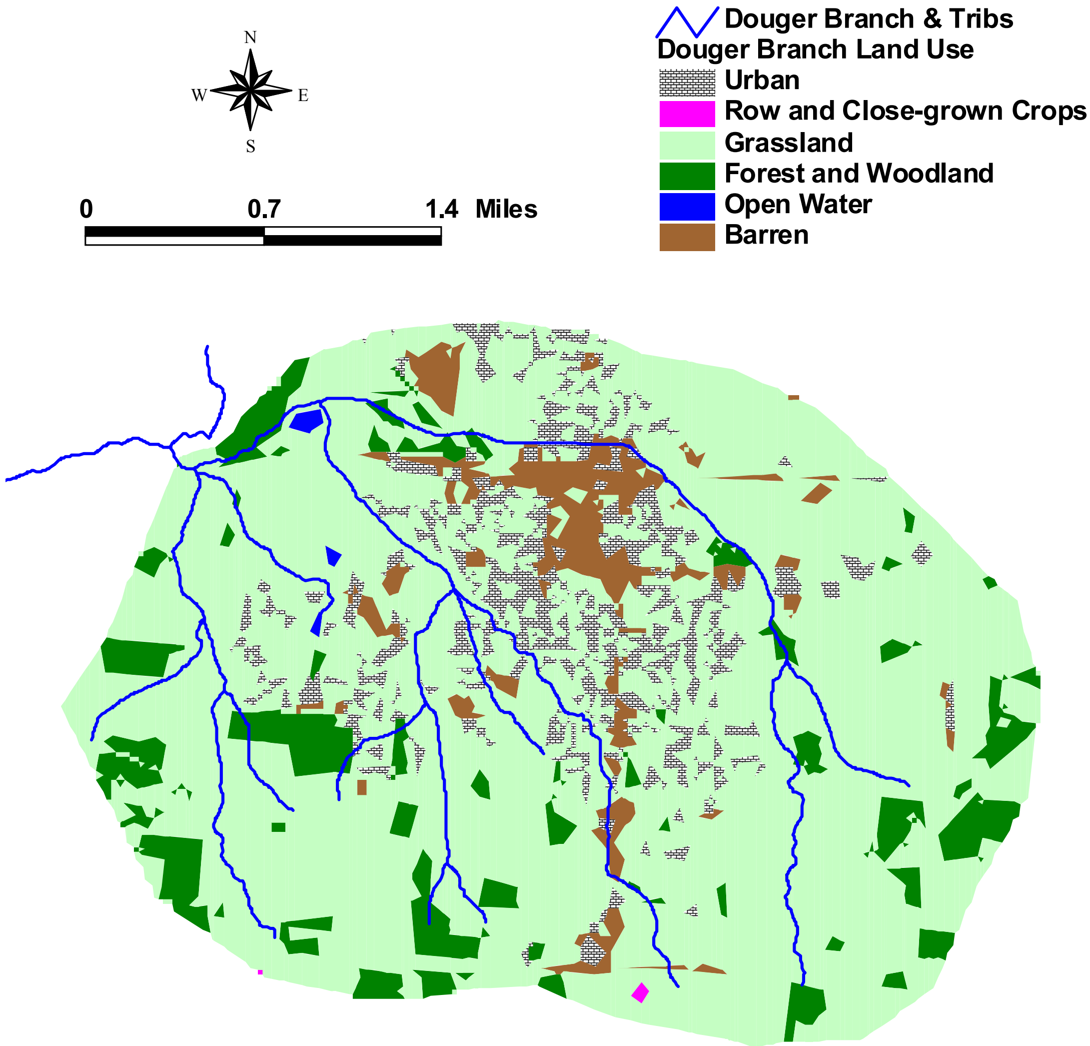
An administrative record on the Douger Branch TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes the following:

- DGLS survey of Douger Branch: "Chat Creek TMDL, Lawrence County, September, 2001" by Jerry L. Prewett
- Preliminary Assessment/Site Inspection (PA/SI) report for the Lawrence County Mining Sites March 2003
- Douger Branch data
- Public notice announcement
- Douger Branch Information Sheet

13. Appendices

- Appendix A – Land Use map for Douger Branch watershed
- Appendix B – Topographic map showing sampling sites and impaired segment
- Appendix C – Data for Douger Branch, 1996-2004

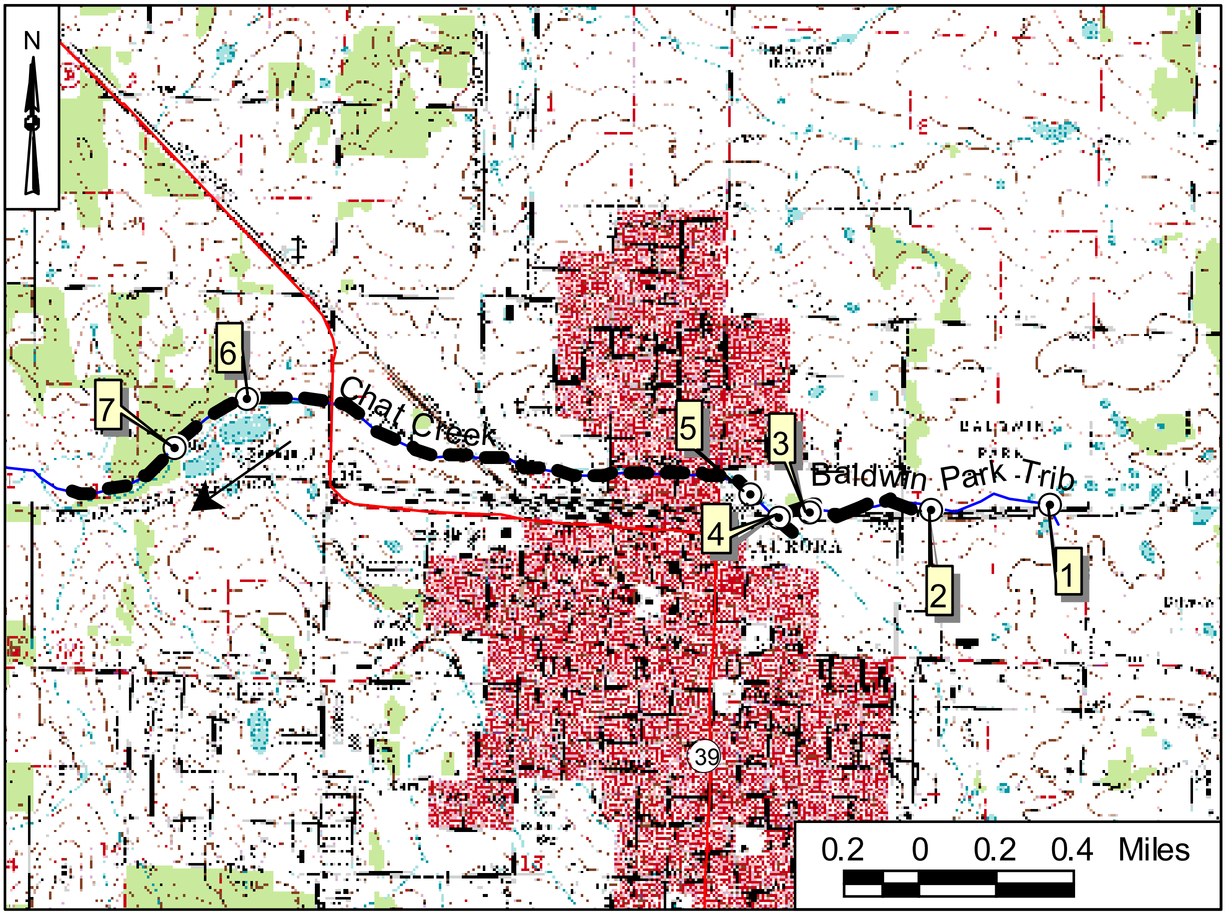
Appendix A - Land Use map for Douger Branch watershed



Landuse	Acres	Percent
Urban	455	8.7
Row and Close-grown Crop	2	0.0
Grassland	4036	76.9
Forest & Woodland	487	9.3
Open Water	9	0.2
Barren	263	5.0
TOTAL	5251	100.0

Data from 2000 (30-meter resolution), obtained from Thematic Mapper imagery, was used to calculate these landuse statistics.

Appendix B
Sample Locations and Impaired Stream Segment of Douger Branch (called Chat Creek on map), Lawrence County, Missouri



Site Index

1 – Baldwin Park Tributary to Douger Branch 0.76 mile above Hwy 39
2 – Baldwin Park Tributary to Douger Branch 0.6 mile above Hwy 39
3 – Baldwin Park Tributary to Douger Branch 0.3 mile above Hwy 39
4 – Douger Branch at railroad tracks just above Baldwin Park Tributary
5 – Douger Branch just below Baldwin Park Tributary
6 – Douger branch just above Aurora Wastewater Treatment Plant (WWTP)
7 – Douger Branch 0.05 mile below Aurora WWTP

Appendix C
Data for Douger Branch 1996 - 2004

Site #	Site Name	Year	Mo	Day	Flow	pH	SC	Hard	TZN	DZN
1	Baldwin Pk. Trib.to Douger Br. 0.76 mi.ab. Hwy 39	2001	3	14		6.8	438			62
1	Baldwin Pk. Trib.to Douger Br. 0.76 mi.ab. Hwy 39	2001	4	16		7.4	343			233
1	Baldwin Pk. Trib.to Douger Br. 0.76 mi.ab. Hwy 39	2001	5	21		7	255			316
2	Baldwin Pk. Trib.to Douger Br. 0.6 mi.ab. Hwy 39	2001	3	14		7.1	555			1090
2	Baldwin Pk. Trib.to Douger Br. 0.6 mi.ab. Hwy 39	2001	4	16		7.4	496			673
2	Baldwin Pk. Trib.to Douger Br. 0.6 mi.ab. Hwy 39	2001	5	21		7.3	365			555
3	Baldwin Pk. Trib.to Douger Br. 0.3 mi.ab. Hwy 39	2001	3	14		6.6	571			2060
3	Baldwin Pk. Trib.to Douger Br. 0.3 mi.ab. Hwy 39	2001	4	16		6.6	593			2190
3	Baldwin Pk. Trib.to Douger Br. 0.3 mi.ab. Hwy 39	2001	5	21		6.9	546			2130
4	Douger Br.@RR tracks,just ab. Baldwin Trib.	2001	3	14	0.28	7	530			237
4	Douger Br.@RR tracks,just ab. Baldwin Trib.	2001	4	16	0.26	7.2	528			143
4	Douger Br.@RR tracks,just ab. Baldwin Trib.	2001	5	21	0.33	7.1	512			166
5	Douger Br.just bl.Baldwin Park trib	2001	3	14	0.74	6.83	546			609
5	Douger Br.just bl.Baldwin Park trib	2001	4	16	0.87	7.1	560			613
5	Douger Br.just bl.Baldwin Park trib	2001	5	21	0.72	7.2	537			594
5	Douger Br.just bl.Baldwin Park trib	2002	7	31		7.8	520			61.5
5	Douger Br.just bl.Baldwin Park trib	2002	10	31		7.4	530			52.5
6	Douger Br @McNatt St., Aurora	2002	7	10	0.25	7.5	532			137
6	Douger Br @McNatt St., Aurora	2003	2	21		6.7	586			484
6	Douger Br @McNatt St., Aurora	2004	3	22		7.8	532			619
6	Douger Br @McNatt St., Aurora	2004	10	6		7.5	571	304		90.6
7	Douger Br. just ab. Aurora WWTP	2001	3	14	0.13	7.1	598			58
7	Douger Br. just ab. Aurora WWTP	2001	5	21		8.1	437			35.7
N/A	Aurora East Wastewater Lagoon	1986	8	27		7	750		13	25
N/A	Aurora East Wastewater Lagoon	1986	8	28		8.1	720		28	16
N/A	Aurora West Wastewater Lagoon	1986	8	27		7	670		4.99	4.99
N/A	Aurora West Wastewater Lagoon	1986	8	28		8	720		12	4.99
8	Douger Br. 0.05 mi.bl. Aurora WWTP	2001	3	14	1.2	8.6	376			45
8	Douger Br. 0.05 mi.bl. Aurora WWTP	2001	4	16	1.9	7.2	617			57.7
8	Douger Br. 0.05 mi.bl. Aurora WWTP	2001	5	21	3.1	7.6	504			33.7
8	Douger Br. 0.05 mi.bl. Aurora WWTP	2002	7	10	0.7	7.8	756			78.1
N/A	Douger Br. 0.25 mi.bl. Aurora WWTP	1986	8	27		7	690		64	23
N/A	Douger Br. 0.25 mi.bl. Aurora WWTP	1986	8	27	1	7.2	720			
N/A	Douger Br. 0.25 mi.bl. Aurora WWTP	1986	8	28		7.5	700			
N/A	Douger Br. 0.25 mi.bl. Aurora WWTP	1986	8	28		7.6	700		41	11
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	1986	8	27		6.5	700		20	17
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	1986	8	27	1	7.2	700			
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	1986	8	28		7.6	675		18	11
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	1986	8	28		7.7	675			
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2002	7	31		8	681			63
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2002	10	3		7.4	739			56.7
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2002	10	31		7.6	507			53.1
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2003	2	21		7.4	607			40.1

N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2004	3	22		8.2	601			69.7
N/A	Douger Br. 1.4 mi.bl. Aurora WWTP	2004	10	6		8.1	797	204		48.2
N/A	Trib. Douger Br. nr. Mouth	1986	8	27		6.5	350		4.99	4.99
N/A	Trib. Douger Br. nr. Mouth	1986	8	27	0.5	7	350			
N/A	Trib. Douger Br. nr. Mouth	1986	8	28		7.7	400		4.99	4.99
N/A	Trib. Douger Br. nr. Mouth	1986	8	28		7.7	355			

Source: Department of Natural Resources

Definition of abbreviations:
SC = specific conductivity
Hard = water hardness as $CaCO_3$ in mg/L
TZN = total recoverable zinc in μg /L
DZN = dissolved zinc in μg /L
N/A = not shown on map
Pk. = Park
Trib = tributary
Br. = Branch
@ = at
RR = railroad
mi. = mile
ab. = above
bl. = below
WWTP = Wastewater Treatment Plant
nr. = near